ITS FIELD OPERATIONAL TEST SUMMARY

Travel Technology

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Introduction

The TravTek ITS Field Operational Test contained a series of field tests, experiments, and analytical studies focused on Advanced Traveler Information Systems (ATIS) and Advanced Traffic Management System (ATMS) concepts. The test was conducted in Orlando, Florida, from November 1991 to June 1994.

Project Description

TravTek consisted of three main components:

- The TravTek In-Vehicle System was installed in 100 specially-equipped vehicles
- The information was collected and processed at the Orlando Traffic Management Center (TMC)
- Customer information and services were provided by the TravTek Information and Services Center (TISC).

The TravTek In-vehicle System for each vehicle had a two-way communication link with the TMC and the TISC via a hands-free cellular phone. The vehicles received a broadcast of traffic information from the TMC and broadcast once per minute to the TMC their locations and travel times across TravTek traffic links they had recently traversed. Figure 1 presents the system configuration and relationships.

The vehicles could be configured three ways:

- Services: provided drivers with local information (yellow pages)
- Navigation: added route planning and guidance capabilities
- Navigation Plus: included all services and navigation features, plus display of real-time traffic information and route planning around congestion.

The TMC received traffic information from several sources, processed this data, and transmitted current traffic conditions to the TravTek vehicles. Data sources included the Florida Department of Transportation Freeway Management Center, Orlando's traffic control system, a network of public and private sector reporting stations, and TravTek vehicles. Information included link travel times, incident status, and the location of congestion. Link travel times were broadcast one time every minute for any of the 1,488 traffic links for which travel times were greater than normal.

The TISC provided help-desk services to TravTek users. It also provided and maintained the navigational map database used in the vehicles. This database represented a 3,100 km^2 area of metropolitan Orlando and consisted of approximately 74,000 navigational road links. The

database was updated and corrected throughout the test. The TISC also managed the local information directory database and the reservation database.

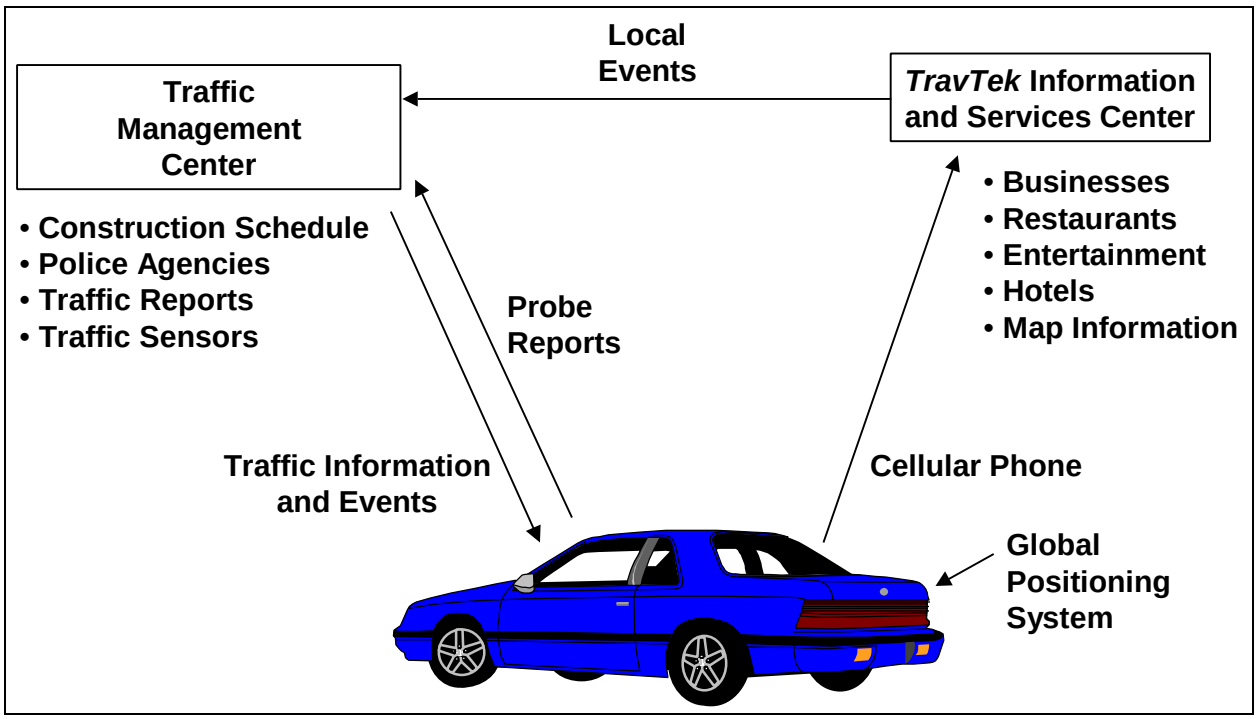

Figure 1: TravTek System Configuration and Relationships

The TravTek Network consists of two types of database links in the coverage area. These links were defined as follows:

- TravTek Links: defined in the navigable database maintained by the TISC (approximately 74,000 links over 16,000 km of roadway)
- Traffic Network Links: represented sections of roadways for which real-time traffic information could be transmitted (1,488 links over 1,854 km).

The TravTek Evaluation was focused around the following questions:

- Will the TravTek system work?
- Did drivers save time and avoid congestion?
- Will drivers use the system?
- How effective were the visual turn-by-turn, moving map, and voice guidance displays?
- Was TravTek safe?
- Could TravTek benefit travelers who do not have the TravTek system?
- Will people be willing to pay for TravTek features?

The field studies consisted of the Rental User Study and the Local User Study. The Field Experiments included the Yoked Driver Study, the Orlando Test Network Study, and the Camera

Car Study. The analytical studies included the Modeling Study (integration), the Safety Study, and the TravTek Architecture Evaluation Study.

Results

The results are presented according to the several main evaluation questions.

Did the system work?

The TravTek system was very reliable. System up-time exceeded 96 percent. Vehicle-to-TMC and TMC-to-vehicle communications were reliable enough to meet system requirements.

The probe vehicle concept worked very well. The TravTek vehicles distributed themselves across the network such that with a greater number of vehicles deployed, excellent network coverage could be achieved for obtaining probe vehicle travel times.

The distributed architecture performed well. System reliability and the perception of reliability resulted, in great measure, from the ability of the vehicles to perform their own route planning. Centralized route planning would have placed more demands on TMC infrastructure while increasing the vulnerability of the system to single-point failures.

The overall accuracy of the TravTek databases was high. The fuzzy logic algorithm for fusing traffic data at the TMC worked well.

The system provided a very high level automation: travel-time data was collected, processed, and distributed to the vehicles without the need for operator intervention. Incident data required intervention and changes in operator training and interfaces were recommended.

A need for better incident reporting was identified. The system did not have enough active incident data sources. A need for procedural changes to increase incident reporting timelines was also identified.

Drivers found the system easy to learn, easy to use, and useful. Aside from the reliability of the traffic information, users perceived the system to work well.

Did drivers save time and avoid congestion?

TravTek was found to save trip-planning time and to reduce travel time. Real-time traffic information did not further reduce TravTek users' travel times, but the modeling results indicate that when using real-time traffic information, TravTek reduced network congestion and therefore reduced overall network travel times.

In all three field experiments the results were uniformly positive: for trips to unfamiliar destinations, both visitors and local users saved considerable time in planning trips when they used the TravTek system.

The TravTek route guidance system was found to reduce travel time in all three field experiments, regardless of the TravTek display configuration used to communicate routes to the drivers. The TravTek Navigation Plus configuration was shown, in the Yoked Driver Study, to successfully avoid congestion. Although the TravTek system helped vehicles avoid congestion, there was no observed travel time savings associated with congestion avoidance. To avoid congestion, vehicles took slightly longer routes on lower-class roadways and, as a result, travel time remained about the same.

Will drivers use the system?

Those rental users who drove with the Navigation Plus and Navigation configurations used the TravTek system on approximately 80 percent of all their trips.

At the end of 2 months of experience with the system, local users were still using TravTek to plan routes for over 40 percent of all their trips.

Responses indicated that people will use TravTek-like systems for route planning and route guidance.

Services users used TravTek on 37 percent of their trips: an indication that there is a demand for in-vehicle databases of local services and attractions even when it is not integrated with a navigation and route guidance system.

How effective were the turn-by-turn, moving map, and voice guidance displays?

There were few differences in driving performance among the alternative display configurations. Overall, workload measures indicated that any TravTek configuration was preferable to the control configuration. Among TravTek displays, the Route Map without supplemental Voice Guide instructions yielded slightly higher workload and marginally lower performance compared to the Guidance Display (with or without Voice Guide), the Route Map with Voice Guide, or the Voice Guide alone.

Drivers generally reported that the TravTek route guidance option helped them pay more attention to their driving and helped them find their way. Among the TravTek display combinations, the field experiments showed the Guidance Display with Voice Guide yielded the most safe driving performance.

Rental users, who were largely visitors to Orlando, used the turn-by-turn Guidance Display far more than the Route Map. Rental Users also tended to leave the Voice Guide on—over 85 percent of the time—while they were driving.

Local users also used the Guidance Display more than the Route Map, and kept the Voice Guide on more than off. Local users used the Route Map more than renters (about one-third of the time) and drove with the Voice Guide on approximately 70 percent of the time.

For route guidance, TravTek results strongly support the use of supplemental voice instructions, as they yielded better performance than visual displays alone. In designing future systems, if a decision must be made between moving map and turn-by-turn displays, the TravTek results—both performance and user performance—favor the turn-by-turn display. Only one example of each type of display was evaluated in TravTek. Therefore, this recommendation may not be applicable to all implementations of turn-by-turn or map displays.

Was TravTek safe?

The field and safety studies showed that ATIS can be employed under normal operating conditions without degrading safety. There was no evidence that TravTek was the cause of any accidents, and the number of accidents involving TravTek vehicles did not appear to be greater than would be expected based on national averages.

The TravTek Safety Study contains an extensive discussion of the problems involved in interpretation of ITS operational test accident experience. With accident probabilities measured

in millions of vehicle kilometers per year, and ITS evaluations typically compiling fewer than 2 million kilometers per year, techniques other than accident and incident tabulations and accident investigations should be employed to meaningfully evaluate safety.

The TravTek Safety Study made extensive use of modeling to project safety impacts of the TravTek system for both TravTek-equipped vehicles and for non-equipped vehicles sharing a network with equipped vehicles. The results projected that, under levels of market penetration higher than 30 percent or on networks with traffic demand no higher than that observed in Orlando, there would be no increase in safety risk. In the absence of congestion, the TravTek system results in a safety benefit regardless of level of market penetration because its routing algorithm has a bias towards safer roadways. A TravTek-like system was projected to present a slight increase in risk to users under conditions of high traffic demand and low levels of ATIS market penetration. Under these conditions, TravTek vehicles divert to less safe roadways when primary routes are congested. With low market penetrations, a high percentage of TravTek vehicles would divert under high traffic demand. With higher levels of market penetration, only a small percentage of TravTek vehicles need to divert and the overall reduction in congestion results in a net safety benefit. The Modeling Study findings apply to conditions similar to those in Orlando and to systems equipped similar to the TravTek Navigation Plus configuration.

Could TravTek benefit travelers who do not have the system?

The Modeling Study findings suggest that traffic network users, both those equipped with the systems and those not equipped, would derive numerous benefits, largely because TravTek-equipped vehicles avoid congestion and thereby avoid increasing congestion. Thus, benefits grow directly with market penetration for most measures of effectiveness.

From the Modeling Study, as market penetration increases, non-users will experience substantial benefits in reductions to travel time, number of stops, fuel consumption, and hydrocarbon and carbon monoxide emissions. Non-users can expect an increase in nitrous oxide emissions, which are associated with higher speeds.

Will people be willing to pay for TravTek features?

Across all field studies and experiments, users indicated that they would be willing to pay more than $900 for a TravTek system. Fifty percent of the Navigation and Navigation Plus renters indicated that they would be willing to pay $1,000 or more. Fifty percent of the Services configuration users indicated they would be willing to pay $500 or more for a similar type of system. The median willingness-to-pay estimate from local users was slightly under $1,000. Across all field studies, median estimates of added-value of the full TravTek system in a rental car ranged from $28 to $35 per week. There appears to be a strong market for the TravTek systems if they can be priced close to or less than $1,000.

Legacy

The system ceased operations as a test immediately after data collection was complete. Some individual components of the physical infrastructure, such as the video cameras on I-4, are still being used to provide traffic management functions in the Orlando area.

The results from TravTek provided a springboard for later ITS deployments, including the Atlanta ATMS and the Model Deployments Initiative. Partners that were a part of this test have been very active in commercial enterprises to deploy vehicle navigation systems nationally.

Test Partners

American Automobile Association

City of Orlando

General Motors

Federal Highway Administration.

References

Federal Highway Administration, Turner Fairbanks Highway Research Center, TravTek Global Evaluation and Executive Summary, Publication #FHWA-RD-96-031, March 1996.